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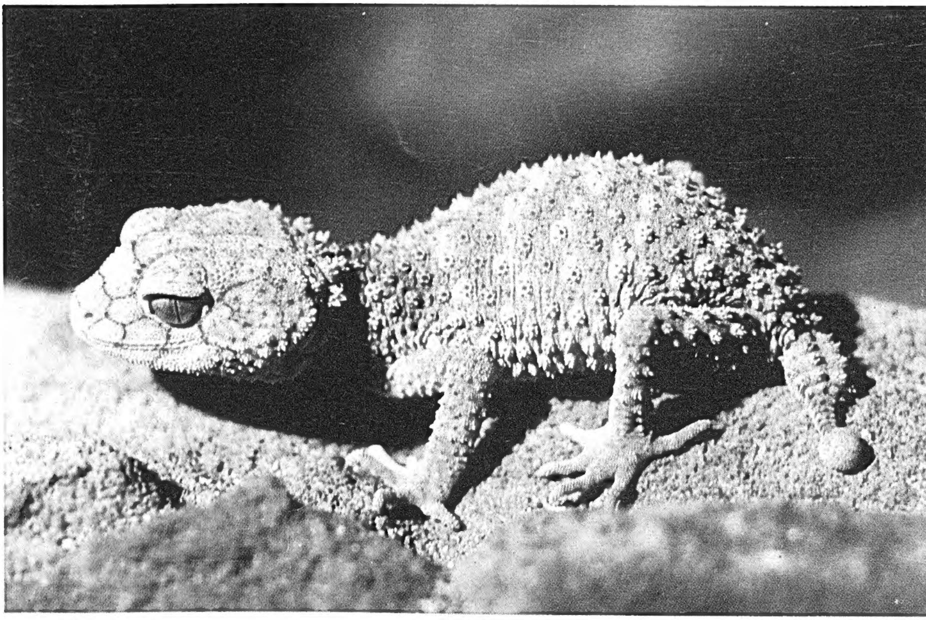
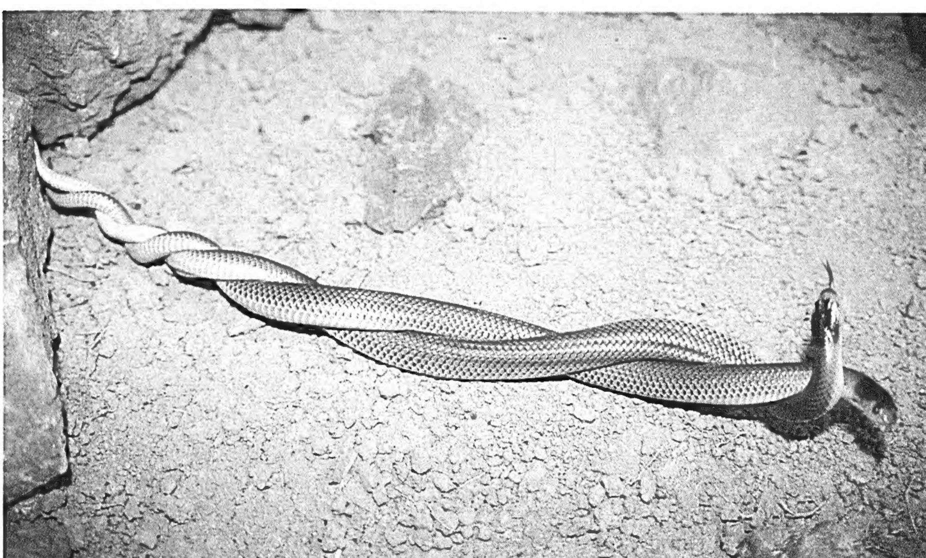


An adult female Spiny Knob-tailed Gecko (Nephrurus asper) showing the distinctive spinose scales. An article on this species appears in this issue. T. Annable



A pair of male Little Whip Snakes *(Rhinoplocephalus flagellum)* engaged in male combat. Featured in an article in this issue. G. Turner

Herpetofauna incorporates the *South Australian Herpetologist* and the *Bulletin of Herpetology* and is published twice yearly by the Australasian Affiliation of Herpetological Societies. The Affiliation started on an informal basis in 1974 and was formally established in 1977. It is the result of a formal agreement between member societies to participate in cooperative activities.

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EDITORIAL
A CASE FOR SIGNIFICANT DEREGULATION OF THE KEEPING AND TAKING OF REPTILES AND FROGS.

(Several herpetologists from Australia and New Zealand contributed to this Editorial).

If efforts to conserve reptiles and frogs are going to be successful, there needs to be a high degree of co-operation between the statutory bodies and herpetologists from all levels. To date, Australian and New Zealand statutory bodies have ignored, almost totally, the following realities. Tyler (1979): "the advent of conservation regulations in some states has created a very serious impediment to the most fundamental research ... blanket regulation involving the total protection of all species in a class ... conjures the analogy of putting every single Australian person in prison, on the legitimate argument that police are unable to distinguish innocent citizens from the few criminals in their midst". Rawlinson (1980): "the advent of conservation regulations in some states has created a very serious impediment to the most fundamental research". Mirtschin (1982): "Most state wildlife departments are unfortunately under the misconception that collecting animals from the wild is a major threat to population numbers". Ehmann and Cogger (1985): "We cannot conceive of any non-commercial harvesting activity which would cause concern for any more than a small minority of Australia's 850 plus species of frogs and reptiles". Greer (1989): "Australia is one of the most exciting and inspiring places in the world to do reptile research and I regret the increasing bureaucratic controls placed on young people and "amateurs" in their efforts to pursue reptile studies". Shine (1991): "State government regulations against the keeping of snakes are often too restrictive". "Amateur snake keepers have also played an important role in finding out more about the habits of Australian snakes. We have so many species of snakes, and so few professional herpetologists, that the professionals alone will never be able to study all of the interesting aspects of all species". Hitchmough (1992): "The ability of at least some populations to withstand heavy, long term collecting pressure could be seen at the "salvage" site at Northcross/Torbay (Auckland, NZ), where the aim was to rescue as many animals as possible, and hundreds were removed, but the populations, particularly *H.granulatus* seemed virtually unaffected".

No assessment has ever been made by wildlife authorities of the effectiveness of blanket type protective legislation in conserving Australian or New Zealand herpetofauna. The existing wildlife laws and regulations "tend to discourage amateur herpetologists and students, and alienates many of those who would otherwise be strong supporters of long term conservation measures" (Ehmann and Cogger 1985). The Fox report in 1974 concluded that "Alteration of habitat was recognised as the major cause of decline in wildlife populations; of far greater significance than direct exploitation of wildlife by man".

Because the wildlife statutory bodies have to date apparently ignored these facts we now face the second biggest problem for reptile and frog conservation in this region. This problem is the unnecessarily slow rate at which we are obtaining the life history details and data needed for effective conservation and management. It is due to unnecessary restrictions, fear of prosecution, and simply failure to get private herpetologists "on side".

To enforce wildlife protection for the many species that are not at risk, involves inspections, confiscations, keeping of confiscated animals by a fauna authority, preparing court briefs, court appearances, clerical support and public relations activities. The resources consumed by this futile work should be put into real conservation measures including developing and maintaining national herpetofaunal status lists, surveying populations, captive breeding of endangered species and providing support for groups, societies and private individuals prepared to work in conservation programs. It should be apparent that at government level financial resources are diminishing. Jenkins (1985) pointed out that "the economics of conservation are such that

governments must necessarily allocate priorities". It is a scandalous waste to be pursuing blanket protection when it is obviously ineffective in preserving native herpetofauna and alienates so many people.

Throughout Australia, for every reptile or frog collected by amateurs, there are an additional 880 killed on the roads or due to scrub clearing. Australia loses 24 million reptiles by domestic cat predation each year (D. Paton pers. comm.). We do not have comparable figures for New Zealand but the range of devastating feral predators including cats and rats can be expected to have a similar impact on its native reptiles and frogs. These figures put the question of amateur collecting into true perspective. The current legislative emphasis on blanket protection is not only a facade but it is dishonest.

Amateurs do make a valuable and significant contribution to herpetology. A survey of popular books on herpetology in Australia and New Zealand shows that amateurs have made an *enormous* contribution. In the Australian region the proportionate contribution by amateurs to both museum collections and the literature is (i.e.was) roughly 40% (Rowlands, 1982). And it must be glaringly obvious to the most sceptical of fauna authorities, legislators and academics that the intervening decade has seen that percentage take an upward jump. Amateurs are contributing substantially to our knowledge and the conservation of herpetofauna, they have very significant potential, and therefore they should be given more opportunity and encouragement to further their activities than at present. Most legislation, regulations, many fauna officers and a significant number of professionals need to change in the direction of co-operation - we all want meaningful conservation, and sustainable biodiversity. That is the best possible long term outcome. Let us work towards that undisputed objective we all (better) have in common.

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The next issue of Herpetofauna is to include papers/articles and notes on the theme of "Conservation, Protection and Private (= amateur) Herpetology in Australia and New Zealand". If you wish to contribute a brief communication or a paper/article on any aspect of this theme, please contact the Editor as soon as possible.

THE CURRENT STATUS OF THE KNOB-TAILED GECKOS *(NEPHRURUS)* IN CAPTIVITY

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There are currently seven described species of *Nephrurus*, namely *N. levis, N. laevissimus, N. asper, N. vertebralis, N. wheeleri, N. stellatus* and *N. deleani* (Wilson and Knowles, 1988). They are all medium to large geckos with a very distinctive appearance, having a relatively large head with a short tail terminating in a small round knob. They are widespread over most of arid Australia, where they are endemic. At least one species, *N. deleani*, is very restricted in range (Wilson and Knowles, 1988). A detailed review of the biology and ecology of the genus can be found in Greer (1989).

This article was stimulated by discussions in meetings of the Reptile Taxon Advisory Group, the body responsible for the overall management of reptiles in Australasian zoos. Geckos of the genus *Nephrurus* were chosen for particular attention, among other taxa, due to the low level of knowledge of their reproductive biology and captive requirements, as well as their desirability for captive collections and their unique morphology. The group acknowledges that some of the animals on which this article is based are probably held illegally, but, while it in no way supports illegal take or trade, it places the wide dispersal of knowledge of our native herpetofauna as one of its highest priorities.

EXISTING STATUS IN CAPTIVITY

a) Australia

Unfortunately, as with many of Australia's smaller reptiles, little work has been carried out with these geckos in captivity. This fact is reflected in the paucity of available literature on their captive maintenance and husbandry, aside from several anecdotal references. Breeding appears to have occurred infrequently and, in the majority of these cases, gravid females have been taken from the wild. A survey of Australian institutions and private keepers in 1990-91 only produced a total of five *Nephrurus* currently held in captivity (2.1 *N. asper* and 1.1 *N. levis*), though it is likely that other specimens are being held privately.

b) Overseas

The international captive status of this group is much brighter, with an estimate of 50-100 specimens of at least four species (*N. levis, N. asper, N. laevissimus* and *N. stellatus*) being held in Europe and the U.S.A. This is undoubtedly a conservative estimate as most specimens appear to be held without the necessary permits. Consequently, the majority of keepers were reluctant to divulge any information on their experience with these reptiles.

The level of successful maintenance of *Nephrurus* is also much higher in both of these continents compared to Australia, and breeding has occurred regularly in *N. levis* and *N. asper*. One keeper in Germany has successfully reproduced *N. levis* over five consecutive seasons, with a 90% success rate in hatching and raising offspring, while another in the same country has hatched and raised *N. asper* over four seasons.

CURRENT HUSBANDRY TECHNIQUES

It is unfortunate that, in general, Australian herpetologists lag far behind their American and European counterparts in the field of captive husbandry and breeding, particularly in the smaller species of lizards and snakes. I will attempt to summarise the current techniques being used with *Nephrurus*, both locally and overseas, in the hope that it may stimulate more interest in these unique and fascinating reptiles.

a) Housing

In most cases, enclosure design and decoration is kept extremely simple. Glass aquaria are commonly used to house these geckos; a 60 x 30 cm tank adequately housing 1.1 or 1.2 specimens. The substrate is usually sand or sandy soil to a depth of about 15 cm. This is maintained fairly dry for *N. asper*, while other species appear to prefer a moistened substrate, at least in part of the enclosure. One American keeper holding *N. levis* provides an overturned plant pot saucer 20 cm in diameter and 3.7 cm high as a home site and the sand beneath is moistened frequently (see Figure 1), a task which is carried out more often when oviposition is imminent. This technique is also used locally with *N. asper* (T. Annable pers. comm.). German keepers also provide moistened substrates for other species, but usually allow them to construct their own home sites in the form of burrows, highlighting the importance of moisture in allowing burrows to be dug without collapsing.

Lighting does not appear to be critical, most keepers maintaining their animals in rooms with access to natural light cycles from windows. Being nocturnal, it would be expected that the UV light required by diurnal lizards is not necessary for *Nephrurus* and results to date tend to indicate this.

Little specific information was obtained on heating enclosures, though one American keeper utilises heat tape which is controlled by a timer to provide hot spots of 31-33°C throughout the year between 6 pm and 8 am. The room where these geckos are held is thermostatically controlled to provide a day temperature of 27°C in winter dropping to 24-26°C at night. In Germany, *N. levis pilbarensis* is successfully maintained and bred at a maximum temperature of 36°C, reduced to 20-26°C at night. A six week hibernation period is also provided, where temperatures are reduced to 12-15°C, during which time water is sprayed regularly into the enclosure. Locally, *N. asper* has been bred in an annual temperature regime of 14-33°C, with a daily variation of 2-10°C (T. Annable pers. comm.). These results tend to suggest that at least some species could be easily maintained inside with only red- or blue-coloured incandescent bulbs providing hot spots, the photoperiod being controlled by natural lighting. It is also interesting to note that *N. stellatus* may deliberately plug its burrow entrance in very hot weather, so this and other species may be able to further manipulate their environmental temperature in captivity (Galliford, 1978).

b) Diet

All reports indicate that Nephrurus feed readily in captivity, taking crickets, mealworms, waxworms and, in the larger species, newborn mice. The food is usually dusted with calcium powder and multivitamin supplement, and is always provided alive. One U.S. keeper feeds twice per week for adults and three times for juveniles and gravid females, and all food is offered in bowls from which the insects cannot escape, but to which the lizards have easy access. By this method he believes the food retains more of the powders and provides a better opportunity for all specimens to capture their full requirement of prey. This is particularly important for juveniles, which require time to develop their hunting skills, yet still need a constant food supply for growth and nutrition. Another advantage of using bowls is that it will tend to indicate when females are due to lay, as food is refused when egg deposition is approaching. Locally, Terry Annable in New South Wales has found that, during their active periods, about three large crickets over two days is sufficient for a female *N. asper* to produce regular clutches of eggs. He has also noted that feeding is reduced at 20°C and stops below 18°C.

Freshwater in small containers is supplied at all times by most keepers, while others prefer to spray the enclosures or home sites regularly, as no observations had been made of geckos drinking from standing water. Perhaps a combination of the two techniques would be ideal as,

although some species prefer to drink droplets from their own body surface or other objects, it is essential that water be available to any captive animal whenever it is required.

c) Reproduction

North American data suggests that captive-bred female *N. levis* are capable of breeding at ten months of age, though this may be unadvisable as it may result in poor egg-shell quality, malformed embryos or poorly developed neonates and may place undue stress on the still-developing female. Copulation has been reported as lasting around 30 minutes in *N. asper*. German keepers have observed females basking in warm spots during the day three or four days before oviposition, and gravid females have also been seen digging their laying burrows during daylight. These burrows are usually in moist sand beneath the home sites, though they will also be excavated in the open, and are around 15 cm deep.

The two soft-shelled eggs of *N. asper* are about 27 x 15 mm in size and are rolled between the hind legs for as long as two hours, possibly to assist in hardening the shell. Double clutching has been reported in captive *N. levis*, with periods of 22-58 days (average 35 days) between clutches.

The amount of moisture in the incubating medium is fairly critical to the hatching success, particularly with *N. asper*. One German keeper claims minimal moisture is essential for this species. Locally however, eggs have been successfully incubated in a 1:1 ratio of water to vermiculite by weight, with three or four 3 mm holes in the lid of the incubating container to allow some ventilation (T. Annable pers. comm.). *Nephrurus levis pilbarensis* eggs have been hatched in a vermiculite mix which has been moistened and then squeezed by hand to remove as much of the water as possible, and the eggs and media are sprayed regularly during incubation. Reported successful incubation temperatures range from 26 - 30.5°C, with most keepers preferring a temperature of approximately 28°C. Table 1 lists the reported temperatures and times for three species.

Details of raising hatchlings were only obtained from one U.S. keeper. The juveniles are separated into raising boxes 30.5 x 16.8 x 9.5 cm, with a portion of the lid cut away and replaced with insect mesh. The cage interior is as described above for adult *N. levis*, but using a smaller plant saucer, beneath which the sand is regularly moistened. A hot spot of 32.5 °C is provided and is often used. Food is offered in bowls after the juveniles first shed their skin at 4-6 days. Smaller items of the same live prey as given to the adults are dusted with calcium and multivitamin powders, and are readily taken by the juveniles which grow rapidly, especially if temperatures are maintained in excess of 25°C.

CONCLUSION

Despite the excellent work that has been already carried out with *Nephrurus*, there is still a great deal to learn. Such questions as the importance of a winter cooling period, the effect of changing photoperiod length, and the amount of moisture required in the incubation medium, as well as a host of behavioural queries, are just some of the aspects that need to be examined. Accumulated data concerning the common species may also assist with future management plans for the very restricted *N. deleani*, whose current status in the wild may be very vulnerable, as implied by Wilson and Knowles (1988). Further field research on this species is urgently required to accurately assess its situation.

Although much neglected by Australian reptile keepers, geckos are fascinating subjects for captive maintenance and the above evidence indicates that, despite their reputation for being difficult, the knob-tails at least appear to be relatively easy to keep and breed. It is a shame that in Australia we must learn about our own fauna from the experiences of overseas herpetologists. However, I hope this article may help to encourage local keepers, both private and institutional, to place some effort on learning about our smaller and lesser known reptiles.

ACKNOWLEDGMENTS

I wish to acknowledge the help and assistance of numerous keepers in both the USA and Germany who have supplied information, without which this article could not have been written. All of them would prefer to remain anonymous for various reasons, however, I would like to thank them and I hope they continue their excellent work. Thanks also go to Terry Annable for his invaluable co-operation in supplying details of his experiences with these animals. Finally, thanks to those members of the Reptile Taxon Advisory Group, particularly Chris Banks, without whom this article would never have been written.

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Table 1. Temperatures and incubation times for the successful incubation of *Nephrurus* eggs

SPECIES	TEMPERATURE (°C)	INCUBATION TIME (DAYS)	COUNTRY
N. asper	28	90-100	Germany
N. levis	30 28-28.5 26-28 26-28	62 70 61 63	Australia USA Germany Germany
N. deleani	29-30.5	55-56	Australia*

*Delean and Harvey (1984)

Figure 1. Housing for *N. levis* with home site lifted and dampened sand underneath

OBSERVATIONS ON THE HUSBANDRY AND CAPTIVE BREEDING OF *NEPHRURUS ASPER,* THE SPINY KNOB-TAILED GECKO

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INTRODUCTION

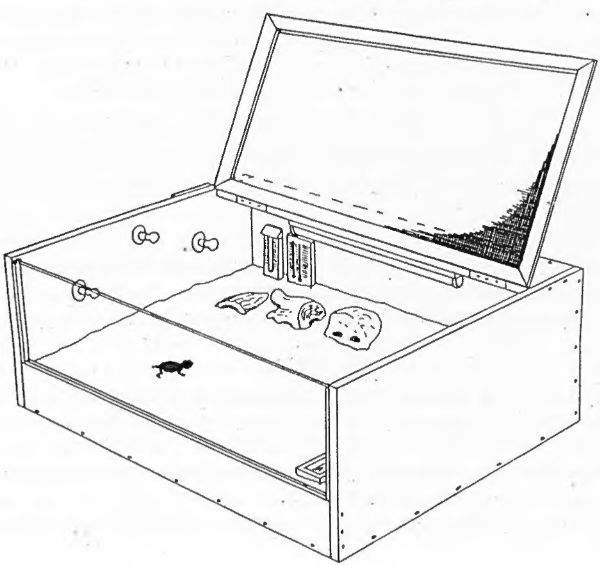
Numerous photographs, diagrams and brief descriptions of knob-tailed geckos and their alarm behaviour are available in popular books and magazines but very little detail has been published on the genus *Nephrurus* and almost nothing in Australia on husbandry or captive breeding. Obst, Richter and Jacob, (1988) referring to *'N. laevis'* advise a temperature range of 18° to 20°C at night and 25° to 30°C in the daytime and also that the 'Lower substrate layers must be kept slightly damp.' H.-J. Sameit, (1988?) referring to *N. asper, N. laevissimus, N. levis and N. stellatus* (in Germany) also give brief advice on husbandry and captive breeding.

The following account refers to a pair of *N. asper* which have been successfully bred by the author using the following arrangements.

HOUSING

The enclosure (Fig. 1) was built of 17 mm thick, white, laminated, waterproof chipboard, this forms the base, the back and both sides. Length 1250 mm, width 750 mm and height 470 mm. The top two thirds of the front consists of a 6 mm sheet of polymethyl methacrylate (Perspex) which slides out vertically (using U shaped extruded aluminium to form a retaining slot) to assist photography etc. The top consists of extruded aluminium fly screen framing, supporting 1.2 mm mesh plastic fly screen material, this allows free flow of air but can be

Figure 1. The terrarium used to breed *Nephrurus asper.*



covered with plastic sheeting to increase humidity if desired. The lid is close fitting to prevent the escape of live arthropods fed to the geckos.

A 150 mm wide strip of laminate extends along the back of the top to which the lid hinges are attached and which also supports the 600 mm Crompton 18 W white fluorescent tube. On the left side are situated three light bulb holders, the two lower ones are about 150 mm above the substrate and 300 mm apart. They have, for example, two 40 W pearl incandescent light bulbs, these can be varied according to the amount of heating required, they are also used to determine the photoperiod which is controlled by the time clock outside on the left. This arrangement of lights provides a significant and variable temperature gradient to facilitate thermoregulation. The upper light bulb is a far red photographic safe light for nocturnal observations. Manual override switches are also provided for the lights (in another much larger terrarium used for breeding *N. levis* I have a built-in under-sand heating unit at one end and a cooling unit at the other end designed to provide a possible temperature gradient ranging from near freezing to about 40 degrees celsius). In areas of possibly extreme temperatures it would be advisable to have built in fail-safe mechanisms to prevent excessive cooling or overheating, e.g. using a deep layer of sand to provide a large heat sink, using multiple low output heaters in case of heater or thermostat failure, or using additional insulation to conserve energy and reduce temperature fluctuations.

A maximum and minimum thermometer and a wet and dry bulb hygrometer are used to monitor temperature and relative humidity fluctuations. The base of the unit is filled with sand to a depth of nearly 150mm and a 50mm deep glass trough, kept well away from the lights to reduce algal growth, provides a continuous supply of water. A piece of bark, a log and a rock with holes drilled in it are also provided as alternative hides. The rock is a piece of sandstone about 250 x 200 x 100mm, the holes were drilled using a large masonry bit to produce relatively small entry holes (just large enough for the geckos to enter) but inside the rock the holes were fanned out laterally to make triangular cavities allowing ample room for turning around or curling up.

CONDITIONS

The relative humidity has varied between about 50% and 90% in a year. These values may be higher than those found in the open in the wild but are probably less than those found in their natural burrows. Although occurring in arid areas these lizards may desiccate if not provided with water. The surface sand is normally kept dry but occasionally I pour about a litre of tap water into the sand under the log or rock to maintain a more natural state allowing burrowing etc. This is particularly important around the time of oviposition.

The annual temperature range has been 14-33°C. The daily variation has been between about 2° and 10°C. Occasionally the lizards will bask under one of the light bulbs perhaps indicating that these temperatures could be increased a few degrees. (Usually I have employed only one low wattage light bulb at a time).

The photoperiod has been maintained at about 14 hours per day in the summer reducing gradually to about 10 hours in the winter. It is my opinion that photoperiod is less important than temperature to breeding as egg laying continued even after the minimum light period was reached and only ceased when the daily temperature range fell to about 19-25°C.

FEEDING

Nephrurus asper will eat many types of live prey especially arthropods and in captivity a wide variety of prey is probably beneficial. Crickets, grasshoppers, phasmids, mantids, moths, cockroaches, beetles, earwigs, silverfish, numerous species of the larger and non-spiny insect larvae, spiders (including *Atrax robustus*), scorpions, centipedes, *scutigera*, woodlice, pink mice, small geckos and even pea crabs have all been readily eaten by the juveniles or adults. Certain arthropods such as millipedes, wasps, ants, tiger moths, bombardier beetles, some

cockroaches and hemipterans in general are not eaten possibly because many of them produce repellant substances. This lizard has no hesitation in attacking large potential prey items e.g. it may kill a very large spider without attempting to eat it. In summer the equivalent of about three large field crickets (*Gryllus spp.*) in two days is sufficient for an adult female weighing 36 g to produce regular clutches of two large eggs.

Drinking behaviour (from the water dish) is similar to that of other lizards but has only been observed on rare occasions when the water is lapped up about four to eight times and the head is then raised and the body angulated to between 15° and 30°C above the horizontal as if to allow water to run down into the stomach (or maybe just to keep a look-out), the process may then be repeated several times. On one occasion a 40 g gravid female *N. asper* was weighed before and after drinking and found to have drunk 0.5 g water. Feeding is greatly reduced around 20°C and stops below about 18°C although activity may occur down to at least 16°C. Defecation, usually in a very limited area of the terrarium, occurs down to at least 17°C. Occasionally the faecal pellets are seen to consist largely of sand and this may be more than just coincidental as members of the closely related genus *Underwoodisaurus milii* have been observed to lick up dry sand almost as if they were drinking. This behaviour could be beneficial in reducing internal parasites and/or increasing mineral intake. In the past no dietary supplements have been used but recently the author has started sprinkling calcium carbonate on the sand of all vivaria as calcium is likely to be deficient when using sand only substrates.

Regurgitation has occurred on at least three occasions, once a recently ingested large centipede and twice a cockroach. In both the latter cases the causal factor was believed to be the sudden drop of temperature to 17.0° and 17.5°C, a similar reaction has been observed to cause regurgitation in other lizards (personal observation).

Regular weighing of the geckos helps to make them more amenable to handling but is also important in monitoring their health and nutritional status.

BEHAVIOUR

Nephrurus asper is not very fast moving and although it will often chase moving prey items, it will also sit at the entrance to its burrow and pounce on those passing by. These geckos are good climbers and would sometimes be found sitting on top of the log or rock provided. The sense of hearing is sometimes used in the detection of prey as shown by their immediate reaction to the scratching of cockroaches etc. on the opposite side of a rock in the terrarium. Both male and female would frequently change or swap their shelter sites and occasionally new burrows would be dug although a lizard only appears to maintain the burrow or shelter site that is currently in use. Both will also vocalise occasionally and may become quite aggressive when alarmed or excited. Although the knob on the tail is known to be sensory in function (Russell and Bauer, 1987) it is used in several different ways and under various circumstances related to breeding and other social interactions, as well as during capture of prey.

Under the above conditions female *N. asper* will slough once every 31.6 ± 7.6 (S.D.) days (range 23-48 days) and males once every 45.3 ± 9.0 days (range 29-56 days), part, but not all, of the difference between the sexes is probably due to the fact that occasionally the sloughed skin is entirely eaten undetected. Sloughing is under endocrine control (Maderson, Chiu and Phillips, 1970) and the pre-oviposition slough no doubt contributes to the greater sloughing rate in females. Sloughing ceases in winter when the minimum temperature reaches about 18°C. Sloughing problems may occur as a result of skin injuries or illnesses such as nutritional deficiencies. If the slough is eaten it usually occurs immediately although on one occasion a slough was not eaten until about 4 days after sloughing and possibly by a different lizard.

N. asper will regularly dig new burrows and will frequently make 'basking sites' where the

surface sand is dug out using the forelimbs and then the sand is pushed away using the hind limbs, the body is then gradually rotated through a semicircle to remove more sand and produce a surrounding mound with the lizard laying flat in the middle. During this process and at other times the gecko will often flick sand up onto its back and head by using the forelimbs, whether this is part of a camouflage technique is not known. Several other ploughing and scraping type movements have also been observed. The amount of activity was gauged by flattening the sand at various times each day and then using a grid system measuring the percentage coverage of footprints the next day. Under subdued lighting the geckos will occasionally emerge during the day but most activity occurs between lights out and three to five hours after, see Bustard, (1967) and Delean and Harvey, (1981).

N. asper swims in water by the vigorous use of the legs, the very short tail being useless for this purpose.

Change of colour is often quite dramatic, e.g. from a very pale creamy brown to a dark brown within five minutes. When active, the lizard is usually pale but tends to turn dark when in hiding.

HEALTH

Apart from the sudden death of two specimens in one terrarium due probably to cyanobacterium intoxication, no significant health problems were encountered during two and a half years of observation. No macroscopic parasites either external or internal were evident on wild caught specimens.

BREEDING

An adult pair, an old female at least 12 years old (according to Taronga Park staff), of 110 mm snout-vent length and weight 36 g, and a young male about three years old (estimated from the fact that it was subadult and still growing at time of capture), of 89 mm snout-vent length and weight 25 g, were kept together in the enclosure throughout the year, only occasionally would they be found together in the same shelter. Mating seems to occur above about 24°C (as evidenced by cessation of egg laying in the autumn). For comparison the mating of *N. levis* has been observed at a minimum temperature of 21.8°C. Gestation may be as short as 23 days probably depending on nutrition and temperature.

Like most other gekkonids *Nephrurus spp.* usually lay two eggs but occasionally only one (of nine clutches laid by one gecko three consisted of a single egg). Up to five clutches are laid in one season but the number no doubt depends on temperatures and food availability. The eggs measure 25-28 x 14-18 mm when laid and weigh 3.86 ± 0.57 g. growing to 4.41 ± 0.46 g at the time of hatching. The oviposition sites are dug in damp sand to the full depth in this enclosure (they may prefer a significantly deeper layer), the eggs are laid close together and the hole is back filled over a total period of up to several hours. When first laid the eggs are sticky and may adhere to one another. Sand grains may be stuck over most of the surface, and under the microscope these sand grains are seen to be embedded in the outer layer of the dried shell. When discovered, the eggs were immediately dug up and loose sand brushed off then weighed, measured and placed on damp, coarse vermiculite (about 1 : 1 distilled water to vermiculite by weight) in half litre plastic containers. Three or four holes about 3 mm in diameter were made in the lid to maintain a slow exchange of air and reduce condensation. During incubation the total weight of the container plus eggs was occasionally restored by the addition of more distilled water.

The hatchlings emerge after 117-122 days at an average incubation temperature of around 28°C, (range 20-34°C). The average hatchling weight was 2.513 g, (range 2.068-2.886 g) and average length was 58 mm, range 57-59 mm. They lose their two egg teeth, not necessarily simultaneously, after about two days and at about the same time that they start feeding on small arthropods. They then start to put on weight rapidly, providing a temperature of about 25°C+ is maintained. Juveniles may be sexed almost from the time of hatching, the males

having larger postcloacal eminences due to the developing hemipenes. Because adult *Nephrurus* geckos are known to eat other small geckos (personal observation) the young were kept separate from the adults.

ACKNOWLEDGMENTS

Thanks are due to Avondale College for providing terrarium facilities and to the Avondale College Foundation for assistance with travel and other expenses.

Special thanks are due to Terry Boylan of Taronga Park Zoo for technical advice and particularly the loan of a female *N. asper*. The help and co-operation of the National Parks and Wildlife authorities is much appreciated. Thanks also to all those herpetologists who have tried (almost without success so far) to obtain further specimens of *Nephrurus* species.

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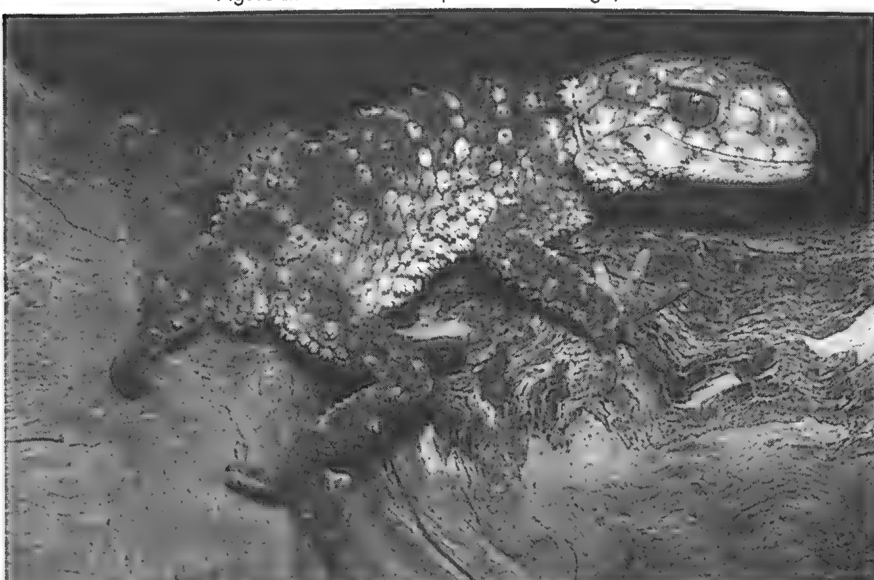
Figure 2. A female *N. asper* from Duaringa, Qld.



GLUE TRAPS: AN APPRAISAL OF THEIR USE IN RESIDENTIAL AREAS OF PERTH, WESTERN AUSTRALIA

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INTRODUCTION

Along with several others in Western Australia I hold a licence to remove nuisance reptiles from houses and backyards. Most other states also have provision for the catch and release of such reptiles. A problem that I often come up against is the uncatchable snake or lizard. It is always there when I am not and never there when I am. It basks in the same place every day but knows when the catcher is on the way. It lives beneath a massive slab of concrete, or amongst boulders that form the foundation of the building, or in a wall cavity. The householder is having an anxiety attack and gives you a look which says "you are not much good at what you do". They then go on to inform you that they should have taken the Agricultural Department's advice and put out a narrow-necked bottle containing a little milk to trap the elusive reptile!

In 1987 I read an article (Knight, 1986) from North America on the capture of snakes in residential areas using glue traps. These are plastic trays of non-toxic glue that will release with the application of vegetable oil (household cooking oil). Whether they work or not on Australia's reptiles was yet to be ascertained, but it would at least allow me to suggest to the householder an alternative course of action. At the time I could not locate an Australian supplier so I contacted J.T. Eaton & Co., Inc., Ohio direct and they kindly forwarded me samples of the various sized glue traps.

APPRAISAL

The trap I found most suitable was designed for catching rats. It measures 241 x 127mm and contains glue to a depth of about 7mm. Although to date I have always used these traps separately they could be used in tandem (2 or more tied together) to trap larger lizards and snakes. The success rate of 30% in catching the target reptile is not much below my success rate of about 45% for locating and physically catching the beast by hand. In Perth the species most commonly found around buildings is the Dugite *(Pseudonaja affinis)*, a very mobile, nomadic snake that rarely stays still for long.

The largest snake I have caught using a single glue trap of the above sizes was a 1.2 metre Dugite. Only the other day an adult King Skink *(Ergernia kingii)* with a total length of about 60cm was caught after it had been mistaken for a snake. It was living beneath the concrete floor of an office and only the head poking out or the tail going in had been sighted. Within an hour of the trap being positioned it was stuck. The smallest reptile trapped inadvertently was the skink *Menetia greyii.*

Once the animal is trapped the owner of the property can notify you to come and remove it. A little vegetable oil poured over the animal where it contacts the glue allows it to come away quite easily. This in turn destroys the trap, however, as they are intended to be discarded along with the trapped pest and are quite cheap to purchase, this is no real problem. Any excess glue can be removed from the skin of the reptile with this same oil prior to its release.

When positioning the glue traps one must take into consideration any household pets like cats and dogs. If pets are free-ranged in the area then the traps are best placed beneath half sections of PVC pipe or similar. I will not set traps inside aviaries for obvious reasons - imagine some rare finch stuck fast. The owner would not be impressed, even if the stress did not kill

the bird, it would end up with bald patches. I doubt if a stuck bird could be removed without leaving many feathers behind. Little children can be a concern also. They could become sticky from head to toe. Furthermore, just imagine you had been successful in trapping a venomous snake, and the youngster has unhindered access to it: the stuck snake is not going to be real friendly!

Two or more glue traps are positioned around the entrance to the hole being frequented by the target, or in the area where it has been observed basking. If it crawls out of a wall cavity I find with snakes, but not with lizards, that they move out along the wall, so position a trap either side of the hole in contact with the wall. Although with either group it pays to have a third trap directly in front. These traps can be used in ceiling spaces, directly on the ceiling or on rafters, in external roof gutters where local Black-headed Monitors *(Varanus tristis)* like to bask, or any other place where a nuisance reptile may have taken up residence.

During late February through to mid April large numbers of juvenile Dugites occur within industrial areas. Many find their way into factories and, though generally unlikely to pose much of a problem, cause some concern. Several glue traps placed at intervals against the internal walls allow ongoing trapping. Several of these hatchlings may get caught on the one glue trap. The time a trap can be left in position is dependent on the amount of dust and other rubbish settling on or blowing onto the glue. I have left traps for up to two weeks in protected positions but do not recommend more than about a week. As with any trap used to secure and hold living animals they must be checked daily so that both the target and non-target animals can be subjected to minimal stress.

The traps have a hole on one corner to allow them to be secured by string to a stake or something else nearby. They sell for about $10 a pair and today are available from some stock suppliers and commercial bird dealers. As an integral part of the reptile catchers equipment I rate them number one. Not only do they allow you to catch the elusive individual but, more importantly, allow you to offer a method of trapping to a concerned resident that *works* while you are not there.

GLUE TRAPS are imported by Globe Chemicals & Trading Pty Ltd, 441 West Botany Road, Kogarah, NSW 2217 and their Queensland address is 14 Ammie Street, Rocklea 4106 (07) 277 3999. They are available in Western Australia from Robert Lintons Pty Ltd, 55 Canning Highway, Vic Park 6100 (09) 361 6922.

ACKNOWLEDGEMENT

I thank Michael E. R. Godfrey and J.T. Eaton & Co. Inc., for providing the package of traps for appraisal.

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COURTSHIP BEHAVIOUR AND MALE COMBAT IN THE LITTLE WHIP SNAKE *RHINOPLOCEPHALUS FLAGELLUM* (ELAPIDAE)

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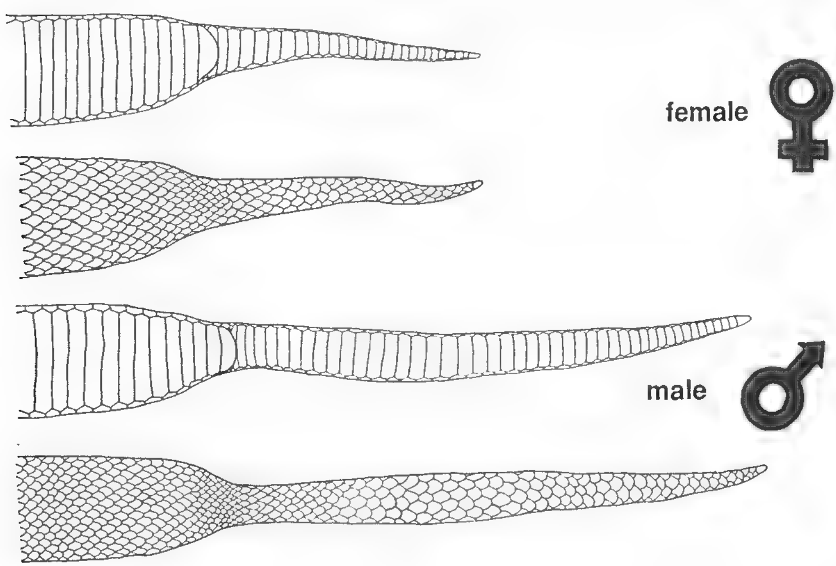
ABSTRACT
Courtship behaviour and male combat is described in the small, nocturnal elapid, *Rhinoplocephalus flagellum*. These behaviours are very similar to those described in other (larger) elapid snakes and the observation of male combat is consistent with the occurrence of sexual size dimorphism (males larger than females) in this species.

INTRODUCTION
Courtship, copulation and male combat have been recorded in a number of Australian elapid snakes particularly the large and more conspicuous elapids (see Shine 1977, 1978, 1991 and Shine & Allen 1980 for an overview) though only in a handful of species have these behaviours been described in any detail (CS = courtship, M = mating, CB = combat; *Pseudechis porphyriacus:* Fleay 1937, 1951 a, b (CB); Baker 1969 (CB); Rankin 1976 (CS & M); Shine et. al. 1981 (CS & CB), *Pseudonaja textilis:* Fleay 1951 a, b (C), *Austrelaps superbus:* Shine & Allen 1980 (CB), *Oxyuranus scutellatus:* Hosmer 1953 (CB). *Acanthophis antarcticus:* Hoser 1983 (M); also see Worrell 1963). The genus *Rhinoplocephalus* (see Ehmann (1992); formerly *Unechis*) is of particular interest since it is representative of the secretive, small elapid genera and its members exhibit sexual size dimorphism (males are larger than females; Shine, 1988). In *R.flagellum* there is another more reliable and conspicuous secondary sexual character namely a pronounced difference in the shape and length of the tail (Fig. 1). Male combat had not been observed in this genus (Shine 1991; pers. com.) a somewhat anomalous situation

Figure 1. Sexual dimorphism in *Rhinoplocephalus flagellum*:
dorsal and ventral views of the tail. Drawn directly from specimens.



given that Shine (1978) found intrasexual competition between males is the major selective agent producing large body size in male snakes and on this basis anticipated that male combat should occur in the genus (Shine, pers. com.). I report on courtship behaviour and male combat in a captive group of *R.flagellum.*

A core group of six (one male, five female) *R.flagellum* have been maintained in captivity for the past four years. The group was kept in a 100x45x45 cm indoor enclosure on a fine sand substrate with several basalt rocks for refuge and maintained on a diet of the locally occurring *Pseudemoia pagenstecheri* (formerly *Leiolopisma entrecasteauxii)* and *Lampropholis guichenoti*. While the enclosure containing *R.flagellum* is indoors and heated during the summer, for the rest of the year it is kept at room temperature which approximates quite closely outdoor (air) temperatures. Rocks in the enclosure were sufficiently concave so as to allow reasonable viewing beneath them, although some males would continue their activity unabated even when rocks were removed and the (male-female) pair was exposed directly to artificial light. Other pairs had emerged from beneath ground cover in subdued light, making observation relatively easy. Male combat was observed to take place out in the open and only under subdued light or near-complete darkness (the type of lighting conditions when the species is usually active). In any case the observed behaviour was very consistent and varied little between pairs.

OBSERVATIONS

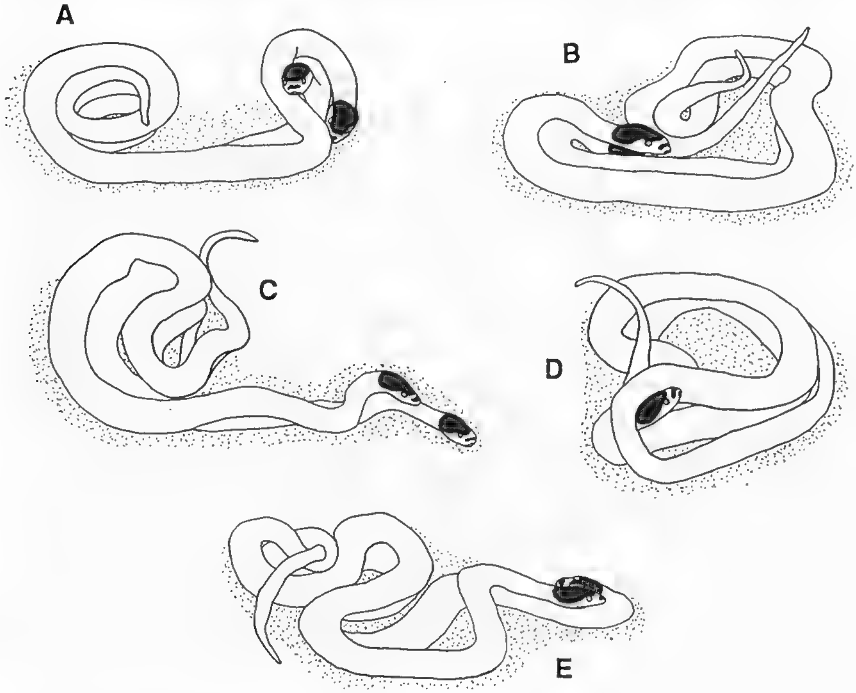
Courtship and Mating Behaviour

Premating (or courtship) behaviour was indicated by restless, incessant movements in males beneath rocks. Males would maintain their activity for up to 2-3 days at a time and intermittently over a 3 week period during September. It is very clearly initiated by the onset of elevated (spring) temperatures. The first 3 or 4 days in succession of 'typical' spring weather (characterised by relatively warm (>17°C) clear days and cold nights (<10°C) seems sufficient to trigger captive males. Mating in local field populations occurs slightly later (October - November (Turner 1989)) with this 1-2 month difference appearing to result from an artificially induced physiological 'lag' (which is typical in specimens maintained under artificial conditions over long periods). The 'lag' is reflected in a similar discrepancy in the timing of post-winter sloughs between captive and field animals.

The details described below are not an account of a single pair but rather an accumulation of observations (courtships n = 11; matings n = 19) made on 17 different pairs. The behavioural sequences were virtually identical for each pair, the only major difference being the length of time each of the particular behaviours were exhibited. Below I quote the courtship and copulation times of those observations for which accurate starting and completion times are available - for matings this is not such a problem since a courting male is rather conspicuous and it is only a matter of watching it carefully until copulation begins and then checking the pair at regular intervals. It is difficult, however, to predict exactly when a male will start courting and so in order to obtain an accurate starting time a courting male was introduced to a 'fresh' female (or vice versa) and then only those courtship times which lead to copulation were recorded (those which did not were generally shorter since females would flee). Courtship times (hr:min (± min)) were 2:25 (10), 1:40 (10), 4:50 (15), 5:20 (15) and copulation 9:30 (30), 7:30 (30), 6:00 (30), 8:00 (30), 5:30 (30), 8:00 (30) (also see Turner (1985) for two additional copulation times). Courtship and mating activities not unexpectedly show a clear temperature dependence occurring during daylight hours as opposed to the cooler nights. However, these activities could be induced at night by artificial heating in the absence of artificial light (see Fyfe & Booth 1984).

Courtship behaviour is characterised by an active male and a passive female. The male encircles the female moving along the length of her body, closely following the contours while maintaining his position on top, in an attempt to 'smother' or cover her with his body (Fig. 2a to e). The male's head and vent are pressed firmly against the female's body and his tongue

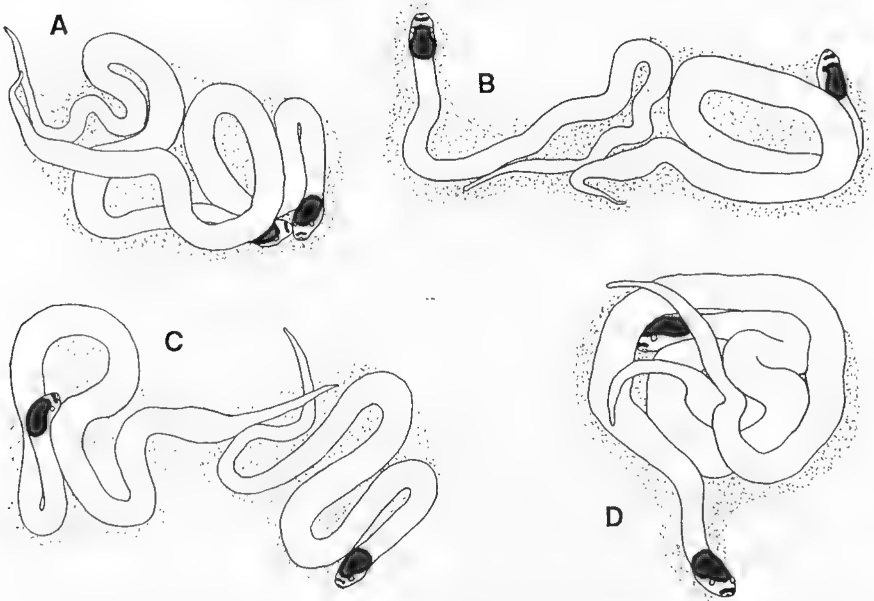
Figure 2. Courtship (pre-copulatory) postures in two pairs of *Rhinoplocephalus flagellum*. In each drawing the male sits on top. Drawn from photographs.



is continually flickering her body as he moves, continually probing with the snout. At various times this activity was interrupted by peculiar quivering and jerking movements by the male in contrast to the usual smooth massaging movement. This usually only lasted 1-2 minutes at most after which the initial activity was resumed. The male does repeated circuits of the female, only occasionally pausing. The male's tail makes manipulative movements in attempts to copulate. Often the tail assumes an arched posture to presumably lend more leverage and assist the positioning of the vent closer to that of the female's. Some males attempted to flip the female's posterior body in a bid to gain access to her vent. Associated with all observed attempts to copulate is a rapid tail wriggling by the male immediately prior to the extrusion of the hemipenes (at this stage the tails and vents are aligned). All females appeared unresponsive and often resisted the male's attempts, frantically emerging from beneath rocks in daylight to seek cover elsewhere with the male in pursuit. On a number of occasions a male was placed beneath a rock containing a courting male and in all instances the introduced male rapidly emerged almost instantaneously, with the resident male in pursuit. Females were usually more 'tolerant' and emerged a considerable time later if at all.

If the male is successful in its attempts to copulate, a markedly different and much more subdued behaviour ensues. There is no set position during copulation, with both the male and female occasionally altering their positions (Fig. 3a to d). Often there was minimal body contact between the pair and the male was not observed maintaining his 'on-top' position in contrast

Figure 3. Copulatory postures in two pairs of *Rhinoplocephalus flagellum*. In each drawing the male is distinguished by its long, thick tail (see Fig. 1). Drawn from photographs.



to the behaviour leading up to copulation. During the later stages, females often exhibited a pronounced pre-anal swelling which subsided 3-5 hours after the pairs broke off (Fig. 3c). A particular pair mates only once (as opposed to say brief multiple matings). I have never observed a female mating with more than one male during a season; males which have or have not mated previously will attempt to copulate with previously mated females though never successfully. The same cannot be said for males which will attempt to and do mate with more than one female. Males will attempt to mate with any number of females and I have observed individual males mating with two females (n=3) and three females (n=1) in the one season.

Male Combat

While courtship behaviour in *R.flagellum* is easily and commonly observed in captive specimens, male combat is much less often observed. I have maintained small groups of *R.flagellum* for some nine years in all (with a considerable turnover during this time) keeping males to a minimum (usually two) and I have only observed male combat on five occasions. Three occasions coincided with the introduction of a new male while the other two instances involved a pair of males being placed together in a new enclosure. While initial encounters were intense, aggressive behaviour died down after two or three weeks though never completely. Combined with the fact that *R.flagellum* only emerges and becomes active under semi or complete darkness, and then only when night temperatures permit, it is not so surprising that observations have been few. In addition combatant males would more often than not break off upon my approach, though on rare occasions (just after introduction when the fighting was most intense) these same combatant pairs would seem oblivious to my presence. Replacing the fine sand subtrate in the enclosure with gravel aided observations greatly since on the gravel substrate the thrashing movements of fighting males were clearly audible (and distinguishable

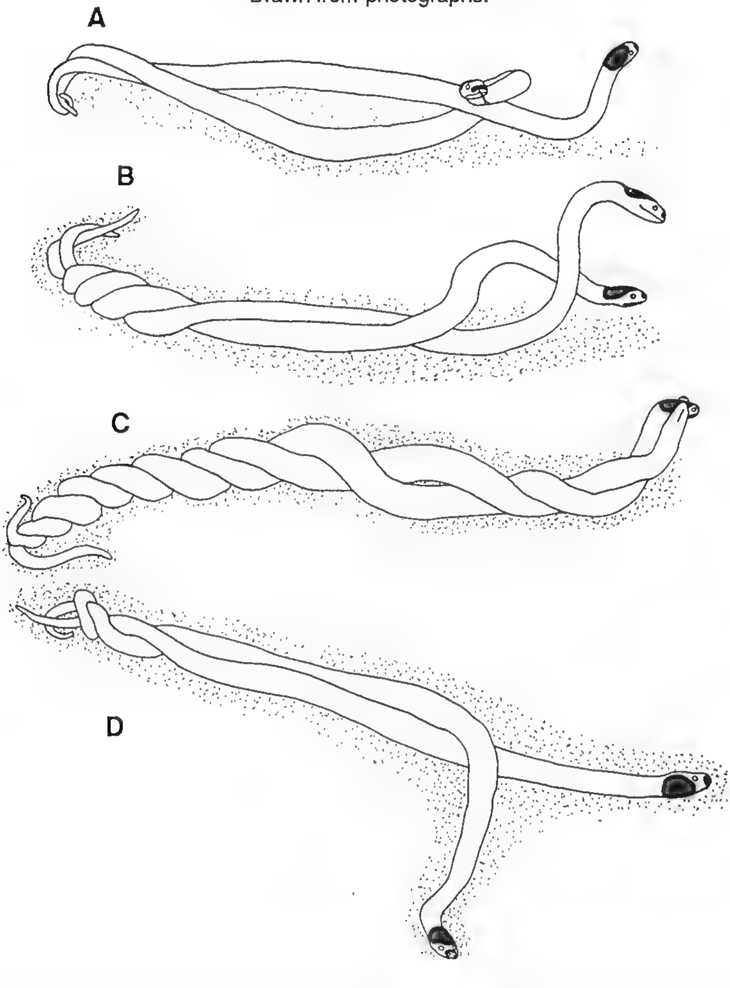
from the noises associated with usual activity; this is not the case with sand) so providing a convenient indicator of periods of fighting. Male combat in *R.flagellum* was clearly hinted at prior to these direct observations by the overtly aggressive interaction between courting and noncourting males (described above) and the observation that adult males in captivity and in the field are only very occasionally found together beneath the same rock. In fact in the field I have never observed two or more adult males beneath the same rock, though other combinations such as adult male/female(s), juvenile(s)/adult male etc. are quite common (Turner, in prep.). In the three pairs of males in which combat was observed, two pairs were of similar size (total length: 379 vs 375 mm, mass: 21.79 vs 22.65 g; total length: 365 vs 365 mm, mass: 27.07 vs 22.41g) while the other pair were of disparate size (total length: 379 vs 290 mm, mass: 21.79 vs 11.70 g; one male was common to two of the pairs). The observations described below took place between July 1991 and June 1992.

Male combat was initiated by the resident male (and not the individual being introduced) upon coming into contact with the newly introduced individual. In the case where two males were placed together in a new enclosure it was observed that one individual consistently initiated combat. In any case the more aggressive of the two males would show interest in the rival male by moving toward him usually from the rear and flickering its tongue along the body of his rival until the two were approximately aligned. The males would then proceed to 'lock' necks, raise their heads up to 10 cm from the substrate, and with the anterior third to half of their bodies and necks horizontally compressed, proceed to engage in fairly frantic thrashing movements (resembling the whip-like posturing of their defensive display (see (1) of Turner 1984)). Each male would endeavour to gain the upper position (Fig. 4a, b). The outcome of these movements was that the pair became intertwined or plaited; starting from the tail these winds (with continued thrashing movements) proceeded up the body right to the head (Fig. 4c). While outstretched and fully plaited the pair continued to push and struggle against one another until the head or neck 'grip' slips, whereupon there is a rapid and rather spectacular undoing of the body plaits (the tails usually remained plaited) leading to the pair eventually breaking (on many occasions quite violently) (Fig. 4d). (A simple analogy is that of an elastic band which is wound up (plaited); winding creates torsion in the band so that when released the band unwinds in a series of rapid rotations - this is exactly what happens in combatant males). On occasions the 'loser' ended up being flung some distance. Bodies of the combatants are rigid and fully outstretched during these bouts and at the stage when plaits have extended up to the head it was not uncommon for one or both males to attempt to bite the other (Fig. 4c). If successful this biting resulted in the victim trying to flee or in a retaliatory bite. When biting occurred it always took the form of a strong grip applied to the forebody, neck or head lasting up to 20 seconds. Such bouts usually lasted from 1-4 minutes and continued intermittently for at least 2-3 hours. The resident male was consistently observed to be the initiator of these aggressive encounters. On several occasions it was observed to pursue a 'reluctant' new male which sought refuge beneath a rock; the resident then appeared to 'search' beneath several rocks before finding the one containing the new male then 'flushing' it out and continuing its pursuit. In one instance the resident male, while in pursuit, approached the introduced male from behind and bit it (on the raised forebody region), retaining its grip for around 10 seconds before the new male was able to break free. There was no scale damage or visible scale wear resulting from this or other actions; nor has scale damage attributable to this behaviour been observed in field specimens. During the periods when fighting was most intense males occupied separate rocks during daylight hours with the aggressive male always beneath the rock with the most females.

DISCUSSION

These descriptions of courtship and male combat behaviour in *R.flagellum* are very similar to those reported in other large Australian elapids, particularly the detailed descriptions of Fleay

Figure 4. Male combat in a single pair of *Rhinoplocephalus flagellum*.
Drawn from photographs.



(1937, 1951a, b). It leads to the general view (though premature given the number of published accounts) that courtship and male combat (in those species which exhibit it) are stereotypical behaviours in the Australian Elapidae. This is overstating it a little for there are likely to be very specific behavioural differences between species (see Shine & Allen 1980). All accounts of courtship describe an active male/passive female with an abrupt change in behaviour following copulation where restless activity in the male subsides. It is worth listing some of these more specific behavioural similarities in courtship - (1) staccato, jerking movements in males; recorded by Fleay (1937), Shine et. al. (1980) and Worrell (1963): I have observed identical movements in courting male *Pseudonaja textilis* in the field and it would appear to coincide with Rankin's (1976) description of male *Pseudechis porphyriacus* 'twitching its forebody' and

Worrell's observation of 'spasmodic twitching' in courting males, (2) chin rubbing and probing by males along the length of the female: presumably these tactile stimuli make the female more receptive and are common to all accounts as is (3) the apparent maximising of body contact by males whilst continually moving. Cogger (1967) in a general description of courtship in Australian elapids comments 'The male sometimes bites and grips the female at some point along her neck, presumably to assist him in getting a purchase on her body'. I have not observed this behaviour in *R.flagellum* nor is it mentioned in the few accounts of mating in Australian elapids. The observation of tail wriggling in males just prior to attempts to copulate would indicate a tactile cue for female cloacal relaxation response (H. Ehmann, pers. com.). In relation to male combat some specific similarities are as follows: (1) head pushing contests and body plaiting ('head locks' and the 'rope grip' as Fleay (1951a, b) refers to them): this behaviour was common to all reports, (2) biting: to date this behaviour has only been recorded in *P.porphyriacus* and *R.flagellum* (this study) and it is not possible at this stage to class it as a generic feature of male combat in the Elapidae. Fleay (1937, 1951a, b) observes significant scale damage resulting from combat in field *P.porphyriacus*. There is no mention of this in other accounts, including this study, so it is difficult to know whether the occurrence of scale damage in a species might indicate a greater frequency or intensity of male combat. Fleay (1951a) also noted that fighting male *P. porphyriacus* 'were redolent in the strong odour peculiar to the species' - *R.flagellum* is also capable of emitting a pungent odour usually as part of its defensive display (Turner 1984) and it was also noticeable during some combat bouts. It would be interesting to examine whether there is any correlation between male combat and the possession of species-specific odours as this may help shed some light on the functional significance of odours (i.e. are they tools used primarily in male combat or species 'markers' or defence against predators or a combination of these?) Covacevich (1975) notes that the observations of male combat are entirely consistent with territorial defence as they are for competition for females (or some as yet unknown motive). However, as Fleay (1951a) points out the two are interrelated - that is to say defending a territory against invading males is equivalent to competing for a female if in owning a territory the male is more likely to enhance its opportunities to mate. Shine (pers. com.) is of the opinion that snakes like *Rhinoplocephalus* probably defend an area around a reproductive female rather than defend an area *per se*. This is consistent with Turner (in prep.) and together with the observations above that males can and do mate with more than one female (with females appearing to only mate once) indicate that the mating system in this species is 'female defence polygyny' (see Krebs & Davies 1987). Male combat does not appear to occur in juvenile *R.flagellum* though Fleay (1937, 1951a, b) notes that fighting males tend to be of comparable size as opposed to the observations in this study. The duration of bouts in *R.flagellum* is similar to those recorded by Shine et. al. (1981) (1-4 vs 2-3 min) in *P.porphyriacus*. The preanal swelling in females which persists for some time after copulation may suggest the existence of a copulatory plug (this could reduce sperm leakage and/or further copulations (Shine, pers. com.)). It would be informative to compare the descriptions in this study to an ecologically 'allied' species such as *Cryptophis nigrescens* in which male combat has also been observed (Shine, 1984) but for which detailed descriptions of combat are presently lacking.

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COLOUR MORPHS IN *PSEUDONAJA NUCHALIS* (SERPENTES: ELAPIDAE) - VARIATION ON A THEME?

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Recent work on the genus *Pseudonaja* has attempted to resolve relationships within the group and in particular within the "species" *P. nuchalis*. Mengden (1985) did much to clarify the situation and in the process stimulated renewed interest in the problem (Bush 1989a, 1989b). This article offers further material for consideration, based upon ten years of observing *P. nuchalis* in the Eastern Goldfields region of Western Australia.

From the observations made over this period I believe that the various colour morphs of this species are merely variations upon a basic, "typical" *P. nuchalis*. This typical specimen is the usual *P. nuchalis* hatchling: top of head and nape black. Brownish to yellow dorsally, with a blackish herring-bone pattern (Storr *et al*, 1986). From this typical *nuchalis* the different colour morphs can develop as the snake matures.

Virtually all morphs possess a nuchal marking of some form. At one extreme this merely consists of a band, a slightly different shade from the ground colour. This band is often associated with the characteristic nuchal chevron which forms the anterior margin of the band. The opposite extreme to this condition is the all black head and nape. A chevron sometimes forms the posterior margin of this black "hood". In cases where the hood extends further onto the nape a chevron can occasionally be seen through the black on the nape. Note that the above conditions are extremes and various intermediate markings can be found. Ontogenetic colour shift involving head markings was noted by Bush (1989a).

A similar situation exists with body patterning. Here the two extremes are the banded and the plain unmarked specimens. With banded specimens the herring-bone pattern has effectively expanded and become more pronounced. Alternatively, the herring-bone pattern may fade and result in a plain, unmarked specimen. However, even with some plain specimens remnants of the herring-bone pattern can be seen when the snake inflates its body in a threat display. As with the head markings, various intermediate morphs exist between the typical *P. nuchalis* and the banded morph.

That *Pseudonaja* species are capable of undergoing considerable colour change has been noted previously (Banks, 1981; Bush, 1989a). My own observations with *P. affinis* confirm this.

I have, on two separate occasions, reared hatchling *P. affinis* in captivity. Both specimens were from the Esperance (33°52'S, 121°53'E) region of Western Australia. They were typical hatchlings, being similar to *P. nuchalis* hatchlings but with a paler body colour (see Storr *et al*, 1986). Initially both specimens matured as normal, with the black head markings gradually fading after each slough. However, after about two years in captivity both had become noticeably darker, and eventually became entirely black dorsally (dark grey, ventrally). The first time this occurred I assumed the specimen was naturally melanistic as black specimens are known from the Esperance region (Bush, 1981, p40). When the second specimen also became melanistic I began to suspect an environmental cause.

Both specimens were maintained in indoor vivaria for most of their time in captivity and artificial heat was supplied when necessary (ie. during winter) to enable them to continue feeding all year. Hence I don't believe the colour shift was directly related to thermoregulation. I suspect the artificial lighting to be the likely cause. This was provided in each case by an incandescent globe. Light from this type of globe is lacking in ultraviolet radiation, which is widely recognised as being of importance to many reptile species (e.g. Blatchford, 1987; Tonge, 1985).

Despite the colour change in *P. affinis* apparently having an artificial cause, these observations serve to illustrate the profound colour change of which *Pseudonaja* species are capable.

Considerable colour variation is not restricted to *P. affinis* and *P. nuchalis.* The African elapid *Naja nivea* occurs in a number of well documented colour phases (Fitzsimons, 1974, pp157-158; Branch, 1988, p93).

In conclusion, I do not wish to over-simplify what is obviously a complex problem. Further work may show that some forms of *P. nuchalis* are indeed separate species; certainly subspecies. At present though, and at least in the Eastern Goldfields, I would suggest that *P. nuchalis* is a single species, albeit a highly variable one. As such I would agree with Bush (1989b) and "...err on the side of conservatism when considering the taxonomic dismemberment of *Pseudonaja nuchalis."*

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NOTES ON THE INCUBATION AND HATCHING OF THE BLACK WHIP SNAKE *(DEMANSIA ATRA)*

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On 29 September 1990 at 1938 hours Thomas Madsen and I caught a gravid *Demansia atra* while spotlighting on Fogg Damm, 60km east of Darwin (Lat. 12.38°S, Long 131.17.7°E).The animal was caught at the western edge of the dam wall where the dry cracked black soil of the flood plain floor was approximately 30 metres from a stand of Pandanus trees.

The *Demansia* measured 751mm snout-vent length, 214mm tail length, with frontal scale length 6.7mm, width 3.65mm and weight 130.3gms. The animal was placed in an aquarium 75cm long, 40cm wide and 50cm high. A substrate of fine gravel to a depth of 10cm, a small water dish and a cardboard hide box (20 x 20 x 10cm) were placed in the aquarium. Oviposition occurred outside the hide box at approximately 0630 hours on October 1, 1990. Ten eggs were laid and all appeared fertile. The eggs were removed from the aquarium and placed on a vermiculite substrate 5cm deep in a plastic container 30cm long, 20cm wide and 8cm deep.

To the vermiculite was added an equal amount of water. When all eggs had been securely placed in the container it was sealed with glad wrap. Small holes (6) were punctured in the lid to allow airflow but keep water loss at a minimum. A thermometer was inserted through the lid into the vermiculite, the container was then placed into a fully enclosed wooden computer desk where the average temperature throughout incubation was 31°C with a variance of ±1°C.

The mass of eggs approximately 1 hour after oviposition was 35.5 grams with the average mass of each egg 3.55 grams. The average length and width per egg was 33.35 x 13.18mm. With the female's weight before oviposition being 130.3 grams and 94.8 grams after, there was a representative weight loss of 27.24% due to the eggs. Individual egg and hatchling measurements are set out in Tables 1 and 2.

Table 1. Egg Dimensions

Hatchling No.	Eggs at Oct. 1		Shells after Hatching
	Length	Width	Weight
1	31.8mm	14.5mm	.695gms
2	37.5mm	13.8mm	.832gms
3	33.7mm	13.9mm	.654gms
4	31.5mm	13.8mm	.683gms
5	32.5mm	14.0mm	.613gms
6	33.7mm	13.1mm	.856gms
7	31.6mm	14.3mm	.601gms
8	32.1mm	14.1mm	.796gms
9	32.1mm	13.7mm	.623gms
10	37.3mm	12.9mm	.596gms
Average	**33.35**	**13.81mm**	**.695gms**

Throughout incubation all eggs appeared white and healthy and when measured on November 2, one month after laying, the average egg length and width was 34.5 x 16.83mm. The eggs were again measured two weeks later on November 14 and the average length and width were 34.51 x 17.23mm. This represented an expansion in average length of 1.16mm and width of 4.05mm.

Hatching began on December 7 1990 and continued until December 10 when the young and the shells were measured and weighed. The average length per hatchling was 217.7mm snout-vent length and 57.35mm tail length. Frontal scale length and width averaged 3.58 x 1.87mm. The hatchlings averaged 4.00 grams in weight and shell weight was .695gm on average. This result indicates that there was an overall increase in weight of some 1.15gms (28.73%), almost one third of the original weight. The actual weight increase was probably more as some fluid would be lost at hatching.

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Many thanks to Dr Thomas Madsen and family for their help and patience.

Table 2. Individual Hatchling Data

Hatchling No.	Hatchling Weight (gms)	SVL (mm)	TL (mm)	Frontal Scale	
				Length	Width
1	3.92	212	57	3.88	2.20
2	4.48	231	59	3.65	1.85
3	4.08	215	62	3.70	2.05
4	3.98	217	51	3.85	1.90
5	3.96	218	56	3.70	1.50
6	4.27	210	51.5	3.35	1.90
7	4.04	221	59	3.40	1.30
8	3.81	218	62	3.45	2.00
9	3.90	218	58	3.50	1.90
10	3.59	216.5	58	3.40	2.10
Average	**4.00**	**217.65**	**57.35**	**3.58**	**1.87**

All Snakes were stretched before measuring.
SVL + snout-vent length. TL = tail length

SOME RECORDS OF REPRODUCTION IN CAPTIVE LIZARDS AND SNAKES

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Relatively few data on reproduction in Australian reptiles have been published for species that are not commonly kept in live collections. Presented here are 18 records of reproduction in egglaying, and 15 records in livebearing lizards and snakes of 20 species. Data included for each record, where known, are date of laying/birth (parturition), female snout-vent length in mm (♀ SVL) and weight in grams (W) recorded immediately after parturition, number of eggs or young (N), egg length/width in mm and weight in gm with means in brackets (E), new-born/hatchling length in mm and weight in gm with means in brackets (Juvenile) and reproductive effort (Re) i.e. total live weight of eggs/young presented as a percentage of female's weight (immediately after laying/birthing). For comparison with other published data which express Re as a proportion of one, move decimal point to the left of first figure i.e. in *Ctenophorus reticulatus* the Re is 59.6 (%) or 0.596.

Unless a locality is shown following parturition date the record is for a specimen from Lort River, Western Australia (33°44'S, 121°17'E).

All eggs were incubated on vermiculite 1 to 1 by weight with water or, more successfully in later records, 1 part water to 2 parts vermiculite. Incubation was carried out in a controlled temperature environment in most cases. In a few cases the eggs were left at room temperature. Those records from Lort River were incubated there and are believed to have been exposed to a range of 12° - 39°C whereas those incubated at room temperature in Perth, Western Australia were exposed to marginally higher temperatures 15° - 44°C.

The high Re (66%) in *Notechis curtus* (N=4) confirms Shine's (1982) belief that relative clutch mass in this species "must be unusually high". If the 1982 record is deleted as possibly aberrant, mean Re rises to 75.9 for the remaining 3 records compared to 51.4 (N=4) in *N.coronatus* and 66 (N=1) in *Rhinoplocephalus nigriceps*, although sample sizes are small.

Taxonomy for the elapid records follows Storr *et al* (1986) especially out of respect for the senior author, Dr Glen Milton Storr (1921-1990): an awesome herpetologist!

OVIPAROUS SPECIES

Ctenophorus reticulatus

11.01.1985	Kalgoorlie	WA
♀ SVL 80 mm	W 12.2 gm	N 7
E mean (17.5 x 9.5) mm		W mean (1.04) gm
Re 59.6		

Pogona m.minor

22.11.1981
N 9
Only one egg hatched after 147 days at room temperature.

9.11.1983		
♀ SVL 108 mm	W 31.8 gm	N 7
E 21-23 (21.9) x 12-13 (12.6) mm		W 1.85-2.06 (1.93) gm

Re 42.6
Juvenile SVL 34-37 (35.7) mm   W 1.66-1.92 (1.8) gm
All hatched late December and early January after 48-54 days at 28°C.

20.11.1983
♀ SVL 123 mm   W 42.8 gm   N 8
E 22-24 (23.4) x 13-14 (13.8) mm   W 2.37-2.86 (2.73) gm
Re 51.1
Juvenile SVL 32-34 (33.1) mm   W 2.02-2.39 (2.2) gm
All hatched early January after 45-49 days at 30°C.

29.12.1985
♀ SVL 123 mm   W 30.7 gm   N 7
E 20-22.5 (21.4) x 12-13.5 (12.7) mm   W 1.92-2.33 (2.1) gm
Re 47.7
Juvenile SVL 35 mm
Only two hatched after 72 and 82 days at 25°C.

Moloch horridus

10.11.1984   Norseman   WA
♀ SVL 91 mm   W 38 gm   N 7
E 23-25 (23.7) x 13-16 (14.1) mm   W 2.57-2.98 (2.72) gm
Re 50

Crenadactylus ocellatus

16.12.1983
♀ SVL 35 mm   W 0.8 gm   N 2
E 8 x 4.5-5 (4.75) mm   W 0.111-0.124 (0.118) gm
Re 29.4

Diplodactylus assimilis

1.02.1984   Menzies   WA
♀ SVL 62 mm   W 4.1 gm   N 2
E 13-14 (13.5) x 8 mm   W 0.39-0.49 (0.44) gm
Re 21.5
Possibly infertile

Diplodactylus pulcher

11.02.1984   Broad Arrow   WA
♀ SVL 55 mm   W 2.47 gm   N 2
E 14-15 (14.5) x 7.5-8 (7.75) mm   W 0.54-0.62 (0.58) gm
Re 47
Juvenile SVL 27-28 (27.5) mm W 0.566-0.579 (0.573) gm
Hatched on 20 March after 39 days at 30°C

Delma butleri

26.12.1984   Leinster   WA
♀ SVL 89 mm   W 5.2 gm   N 2
E 19-20 (19.5) x 8 mm   W 0.799-0.852 (0.826) gm
Re 31.7

Pygopus lepidopodus

13.12.1985
♀ SVL 185 mm   W 26.08 gm   N 2

E 25.5-28 (26.75) x 10.5 mm W 1.65-1.72 (1.69) gm
Re 12.9
Possibly infertile

Pygopus n.nigriceps

14.12.1989 Paynes Find WA
♀ SVL 165 mm W 14.72 gm N 2
E 18-18.5 (18.25) x 12-13 (12.5) mm W 2.57-2.63 (2.6) gm
Re 35.3
Juvenile SVL 72-76 (74) mm W 2.53-2.54 (2.535) gm
Hatched 25/26 February after 73-74 days at 30°C.
Postnatal slough 9 March

Menetia greyii

30.11.1983
♀ SVL 29 mm W 0.423 gm N 2
E 8 x 4-4.5 (4.25) mm W 0.091-0.104 (0.098) gm
Re 45.4
Juvenile SVL 14-15 (14.5) mm W 0.033-0.046 (0.04) gm
Hatched 2 February after 64 days at 25°C.

Morethia obscura

22.11.1982
N 4
All hatched 23-25 February after 93-95 days at room temperature (est. mean 19.6°C)

13.01.1983
♀ SVL 46 mm W 1.5 gm N 4
E 9.5-10 (9.9) x 5-5.5 (5.3) mm W 0.143-0.163 (0.153) gm
Re 40.8
Juvenile SVL 19 mm W 0.15 gm
Hatched 11 February after 29 days at 30°C.

Pseudonaja a.affinis

9.01.1985
♀ SVL 1170 mm W N/A N 11
E 39-45 (40.7) x 18-21 (19.7) mm W 8.45-10.01 (9.4) gm
Re N/A

18.12.1988 Perth WA
♀ SVL 1360 mm W N/A N 13
E 37-42 (40) x 18-25 (22) mm W 8.85-12.9 (11.1) gm
Re N/A
Juvenile SVL 208-219 (213) mm W 5.93-6.82 (6.71) gm
Hatched 1 April after 105 days at room temperature (est. mean 23°C)

22.01.1990 Chidlow WA
♀ SVL 1490 mm W N/A N 27
E 25-32 (29.4) x 15-23 (20.9) mm W 3.23-9.15 (7.3) gm
Re N/A
Juvenile SVL 194-216 (203) mm W 4.75-6.37 (5.59) gm
Commenced hatching 16 March and completed by 24 March after 53-61 days at 30°C.
All but 2 hatched. The failures were very small eggs weighing 3.23 gm and 4.23 gm.

Hemiergis initialis

10.02.1983
♀ SVL 45 mm W 0.585 gm N 2
Juvenile SVL 18.5-19 (18.75) mm W 0.085-0.091 (0.088) gm
Re 30.1

Hemiergis peronii

14.02.1983
♀ SVL 70 mm W 3.413 gm N 4
Juvenile SVL 26-28 (26.8) mm W 0.286-0.299 (0.293) gm
Re 34.3

1.03.1984
♀ SVL 67 mm W 2.57 gm N 3
Juvenile SVL 25 mm W 0.26-0.29 (0.27) gm
Re 31.9

Tiliqua occipitalis

10.02.1983
♀ SVL 290 mm W 282 gm N 4
Juvenile SVL 105-107 (105.8) mm W 26.3-28.3 (27.6) gm
Re 39.1

Notechis coronatus

8.03.1983
♀ SVL 362 mm W 21.06 gm N 4
Juvenile SVL 120-135 (128) mm W 2.24-2.38 (2.33) gm
Re 43.9
Postnatal slough 21 March

31.03.1984
♀ SVL 315 mm W 13.46 gm N 4
Juvenile SVL 102-110 (107.5) mm W 1.4-1.57 (1.48) gm
Re 44
Postnatal slough 11 April

6.04.1984
♀ SVL 348 mm W 25.42 gm N 3 + 4 yolks
Juvenile SVL 118-124 (122) mm W 2-2.18 (2.1) gm
Re 57.8 calculated by including each yolk at mean neonate weight.
Postnatal slough 17 April

30.04.1984
♀ SVL 365 mm W 22.95 gm N 6
Juvenile SVL 126-138 (132.8) mm W 2.14-2.44 (2.3) gm
Re 60.3
Postnatal slough 12 May

Notechis curtus

28.03.1982
♀ SVL 420 mm W 23.67 gm N 8
Juvenile SVL 82-88 (85) mm W 1.03-1.11 (1.08) gm

Juvenile SVL 82-88 (85) mm W 1.03-1.11 (1.08) gm
Re 36.3
Postnatal slough 18 April

27.03.1984
♀ SVL 320 mm W 18.4 gm N 4 + 3 yolks
Juvenile SVL 110-116 (112.5) mm W 2.02-2.1 (2.06) gm
Re 78.3 calculated by including each yolk at mean neonate weight.
Postnatal slough 11 April

13.04.1984
♀ SVL 354 mm W 25.45 gm N 8
Juvenile SVL 110-122 (117.3) mm W 1.95-2.37 (2,17) gm
Re 68.1
Postnatal slough 28 April

9.04.1987
♀ SVL 300 mm W 16.95 gm N 7
Juvenile SVL 102-113 (107.1) mm W 1.8-2.1 (1.97) gm
Re 81.2
Postnatal sloughs 23-25 April

Notechis mastersii

8.04.1987 Madura WA
♀ SVL 234 mm W 5.75 gm N 3
Juvenile SVL 84-87 (85.5) mm based on 2 neonates.
The third was born dead SVL 42 mm.
W 0.58-0.64 (0.61) gm
Re 31.8
Postnatal slough immediately after birth

Notechis s.occidentalis

20.03.1985
♀ SVL 1070 mm W 587 gm N 35
Juvenile SVL 200-218 (208.4) mm W 5.55-6.59 (6.05) gm
Re 36.1
Postnatal slough immediately after birth.
Litter comprised 23 male and 12 female

Rhinocephalus nigriceps

14.04.1984
♀ SVL 322 mm W 10.21 gm N 4
Juvenile SVL 108-122 (115.3) mm W 1.53-1.89 (1.7) gm
Re 66.5
Postnatal slough 22 April

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THE APPARENT SEVERE DECLINE OF THE BRONZEBACK LEGLESS LIZARD *(OPHIDIOCEPHALUS TAENIATUS)* AT ABMINGA

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INTRODUCTION

Field knowledge and experience is one of the most important sources of data for the assessment of the conservation status of reptiles (McDonald *et al* 1991). In the case of a species which occurs in remote areas, is known from very few sites, and which is the only representative in its genus any apparent decline in population numbers is significant and worthy of attention. The Bronzeback Legless Lizard is known from three localities in southern central Australia: a single specimen (the holotype) came from Charlotte Waters, two or three specimens have been taken in the vicinity of Cooper Pedy, and a population study of over sixty specimens was carried out at Abminga (Ehmann 1981).

The Bronzeback Legless Lizard seems to have disappeared from, or experienced a severe population decline in the vicinity of Abminga in South Australia. Recent attempts to find specimens at localities where I knew the species to be common or with suitable habitat have been unsuccessful despite intensive searching. When the species was rediscovered (Ehmann and Metcalfe 1978) and in a subsequent field study (Ehmann 1981), specimens could be found quickly and in good numbers.

OBSERVATIONS

During June 1990 and August 1991 I searched intensively and unsuccessfully for the species at the 1978 rediscovery locality and at 24 other similar sites (Fig. 1) for a total of twelve field hours in each year. Some of these sites were examined during the Exploring Society's Simpson Desert Expeditions 1 and 2 (Ehmann in prep.). Such searchings in 1978 could have yielded at least 50 and up to 100 specimens.

The soil surface and upper horizons during the 1990-91 searches at all 24 sites were significantly altered from the 1978 condition at Abminga: the stable leaf litter blanket was either completely absent or else buried under an extensive sheet of dry and cohesive sediment ranging from 3 to 15cm (mean 10cm, n=25) in depth. This sediment is a sandy silt and clay mixture unevenly interspersed with small to medium sized gibbers and pebbles and sometimes overlain with a thin relatively mobile layer of leaves (Fig. 2).

In some situations at Abminga and at many of the 24 other sites there had been extensive scouring of the soil surface by sheet flood flow (as evidenced by shrub taproots exposed to depths of 4 to 10cm). In other situations at Abminga there were flat delta like expanses between 10 and 30cm deep of loosely packed gibbers and pebbles over areas that in 1978 had a sandy loam surface.

Rhonda and Phil Hillyer reported extreme rain and floods in March 1989, when their Mt Dare Homestead (which is on Abminga Creek downstream from Abminga) was flooded for about two weeks to a maximum depth of about 60cm. Rainfall statistics for Finke, Hamilton and Oodnadatta (ie. where rainfall exceeded 100mm in any month at one or more locations) between 1955 and 1990 are given in Fig.3.

DISCUSSION

The average monthly rainfalls at the three nearest rainfall stations range from 14.3 to 15.9mm (Fig.3). The district falls (203 to 397mm) were indeed extreme in March 1989 - the 397mm total is th highest on record.

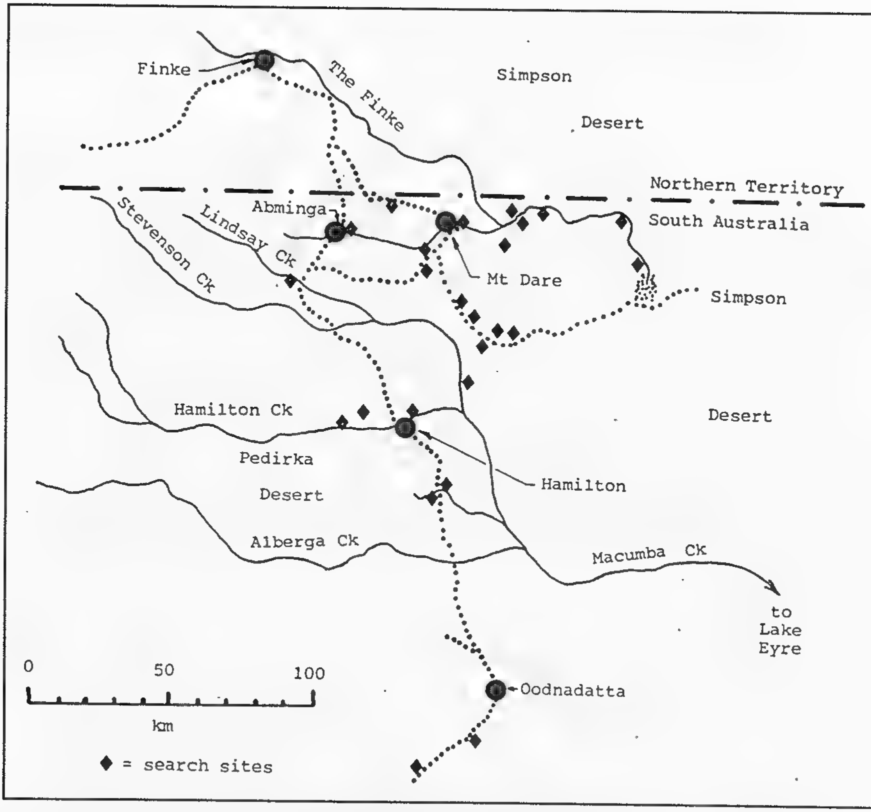

Figure 1. Map of search sites and rainfall stations. Dotted lines = roads and tracks, solid lines = major water courses

This severe nine day drenching accounts for the extensive habitat changes seen. The combination of stripped or buried substrate complex (Fig. 2) has rendered the former habitat much less suitable or unsuitable for Bronzebacks.

The impact of such a deluge on the Bronzeback population and other animal populations requires further field assessment. Some hope could be drawn from other high rainfall statistics: in February 1976 (2 years before the Bronzeback's rediscovery) there were also extreme rainfalls in the district. However there were no buried litter horizons, extensively scoured areas, nor unconsolidated gibber expanses two years later in 1978 (pers. obs. and photographs). I concluded that the pattern of rainfall and runoff in 1989 was very different to that in 1976 and furthermore these resulted in severe habitat change still very obvious two years later in 1991.

It seems that the Bronzeback's decline at Abminga and possibly at other sites where the species may have occurred is due to a natural disaster, a catastrophic habitat change independent of direct human influence. The possible indirect influence of rabbits and stock remains a suspicion: these may (over the past century or so) have significantly altered the nature of the ground surface or reduced the plant cover so that the impact of sudden massive sheet flooding and flow is now far more severe. It is possible that severe local population fluctuations are a normal part of the ecology of the Bronzeback.

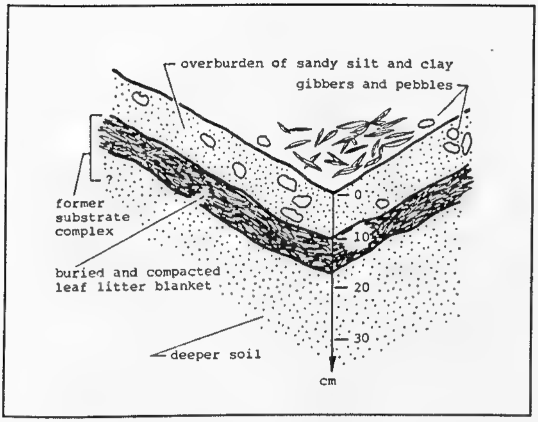

Figure 2. Three dimensional substrate profile of habitat previously inhabited by the Bronzeback. Note the compacted leaf litter blanket buried under sediment.

Table 1. Extreme monthly rainfall at Finke (monthly average 15.9mm), Hamilton (monthly average 15.5mm) and Oodnadatta (monthly average 14.3mm) in Central Australia between 1955 and 1990. mm = monthly rainfall in millimetres, d = number of rainfall days in month, - = data not available (Source: Bureau of Meteorology, Australia).

		1955 Mar	1967 Mar	1974 Jan	1975 Dec	1976 Feb	1981 Jan	1984 Jan	1987 Dec	1989 Mar
Finke	mm	-	149	167	183	301	-	-	-	-
	d	-	3	10	8	9	-	-	-	-
Hamilton	mm	192	138	137	92	366	123	256	103	397
	d	7	3	10	3	8	6	8	4	9
Oodnadatta	mm	-	50	187	30	303	139	273	57	203
	d	-	3	8	5	6	9	12	4	9

RECOMMENDATIONS

Further and more detailed field assessment of Bronzeback populations is required and management procedures may need to be developed to ensure the longterm survival of the species.

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HERPETOLOGICAL NOTES

PREDATION ON *EULAMPRUS TYMPANUM* BY RAINBOW TROUT

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The highland water skink *Eulamprus tympanum* is commonly found associated with streams and bogs in the higher altitudes of the Australian Capital Territory. They have often been observed taking to the water when disturbed (Lintermans unpubl. obs.).

On 28 March 1991 while sampling fish with an electrofisher in the Cotter River, (148°50'E. 35° 38'S), a rainbow trout *Oncorhyncus mykiss* was captured with the neck and head of a sub-adult *E. tympanum* protruding from its mouth. The trout was approximately 20cm in length and the skink had a snout vent length of 4.25cm and a total length of 10.95cm. The trout had only recently captured the skink as the skink was still alive.

Trout are opportunistic predators and usually select the largest and most easily accessible prey (Tilzey 1977). Rainbow trout often feed on the stream bottom and in the water column but are also regular surface feeders. An examination of stomach contents often reveals an abundance of surface insects as well as sticks and leaves (ie. trout may attack almost anything that falls on the water surface). A brief review of the Australian literature reveals that trout diet consists mainly of insects, crustaceans and molluscs (Pidgeon 1981; Cadwallader and Eden 1982; Tilzey 1969) with fish and frogs also occurring in varying quantities (Jackson 1978; Pratt 1979; Weatherley 1964). Occasionally spiders and even a mouse has been recorded in trout stomachs (Butcher 1945). No published record can be found of reptiles occurring in the diet of trout although a skink has been recorded in the stomach of a brown trout *Salmo trutta* from Bradys Lake in Tasmania (Lintermans pers. obs.). Reptiles are unlikely to form a significant part of the diet of trout but, because trout are an introduced species, it would be worthwhile knowing how widespread the occurrence of reptiles are in the diet, and if other reptile species are preyed upon.

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A NATURAL HISTORY NOTE ON THE DRAGON *TYMPANOCRYPTIS BUTLERI*

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Tympanocryptis butleri is a small, lightly coloured agamid inhabiting the light coloured sand dunes and nearby plains of central Western Australia (Greer 1987). During April 13-19th 1992, Robert Browne-Cooper and I conducted herpetological field work on Dirk Hartog Island (Lat: 26 00'S, Long: 113 12'E) in the Shark Bay region where we collected a series of inactive *T. butleri* on white coastal sand dunes by headtorching at night.

During these nightly walks our attention was drawn to small disturbances in the sand in the form of a depression that appeared to have been caused by some animal's activity. Investigating each of these depressions revealed the presence of a *T. butleri* just beneath the sand surface. A total of four individuals were discovered under these circumstances and all were in open areas of sand on the dune, (obviously any animals using the added protection of vegetation would be more difficult to detect).

It can be assumed that to settle into sand these animals used a rapid side to side movement similar to that described for *T. adelaidensis* (True et.al 1981). This sand-shimmying behaviour appears likely as the tail left a distinct imprint in the sand at each depression as if caused by very fast lateral movement as the animal was settling.

Apart from sheltering at night, this ability to burrow rapidly into the sand could assist the animal during the day by enabling it to avoid detection from predators, although the *T. butleri* observed active by day took cover beneath low shrubs and clumps of coastal spinifex. If this burrowing tactic is employed to avoid detection from predators, it may be a case of the animal anticipating the approaching danger by visual or audible cues and therefore having time to hide by sand shimmying. The diversity in *Tympanocryptis* is greatest in arid areas, favouring the hard clays and gibber flats (Wilson and Knowles 1988), so this behaviour of *T. butleri* may also be adopted by other species that inhabit sandy environments.

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SOME RECORDS OF CAT PREDATION ON SNAKES

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"Nothing good can be said of feral cats. Get rid of them."[1]

Domestic cats have also been shown to have substantial effect on wildlife[2] and act as a continual reservoir for feral cats.

We present evidence here on snake predation by domestic cats.

On 4th April 1992, on a warm and sunny day of 25°C about mid day, at Park Orchards, a suburb of Melbourne, a family male Himalayan cat was noticed with a small, 200mm long snake in its mouth. With some encouragement, it reluctantly released the snake and it was subsequently identified as a white lipped snake *Drysdalia coronoides.*

The snake was slender, tan brown, with a bright orange belly. Its injuries were apparently superficial but it was kept for 17 days before release into a nearby reserve.

The cat had previously been reported catching small skinks.

Additional records of cat predation were supplied by Graham Vessey (pers. comm.) from an area around Gisbourne Victoria. Their family cat had preyed on approximately 20 snakes over 7 years which it caught from an area adjacent a dam on their 10 acre property. Some of the details are as follows:

It caught copperheads and brown snakes from 300mm to adult size. It even attempted to catch a 1.8m brown snake but was prevented. All snakes observed were brought back to the house by the cat either still alive or partly eaten.

It apparently had no fear of snakes and was often observed playing with them while avoiding their strikes. It never showed signs of envenomation.

CONCLUSION

This evidence adds to the now growing list of publications concerning the problem of feral and domestic cats in Australia. This evidence supports the action of the Shire of Sherbrooke, Victoria for its landmark decision to enact local controls on domestic feral cats.

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AGGRESSIVE TERRITORIAL BEHAVIOUR OF FREE RANGE WATER DRAGONS *(PHYSIGNATHUS LESUEURII LESUEURII)*

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On 21st October 1978 two adult male water dragons were observed beside Hargreaves Creek, Stanwell Park NSW. The lizards were lying side by side, head to tail. When first observed both dragons were lying motionless and stayed this way for a few minutes.

One lizard suddenly tried to bite the hip of the other male. Both dragons began to move in a circular manner at the same time biting the opponents hip. After several rotations both lizards flopped to the ground and lay motionless. This fighting was repeated several times. I then caught both lizards which were easy to take in their fatigued state. They were measured (Table 1.) and released.

Inspection of the animals showed that they had inflicted injuries to each other, with both animals having bleeding wounds in the region of the hips. Similar injuries were observed in March 1992 on a male at Coalcliff NSW (Figure 1.).

Table 1.

SNOUT-VENT LENGTH (mm)	TAIL LENGTH (mm)	WEIGHT (gm)
235	435	580
225	485	510

note: both animals had the end of the tail missing.

Figure 1. Male water dragon from Coalcliff, south of Sydney, showing battle scars

BOOK REVIEW
AUSTRALIAN SNAKES - A NATURAL HISTORY (1991)
BY R. SHINE.

Reed Books, Sydney. 223 pp 220mm x 290mm. ISBN 07301 03498.
Retail price $29.95.

Although there are many species of Australia's reptile fauna still to be described I think it is fair to say the greater part of the fauna is now described. In many cases, students can not only identify a reptile from one of the many good identification guides available but learn something about its biology too. Unfortunately much of the biological data is scattered throughout the literature and is not easily accessed by the public.

Recently, Harry Ehmann (*Herpetofauna* 20: 35) made the observation that Australian herpetology was entering a new and exciting phase. That new and exciting phase he inferred is, I am sure, the ability of Australian herpetology to produce good, popular texts which go beyond the identification guide and whose generalisations are based on a wealth of primary research.

Rick Shine's book is of the new genre. It is a successful attempt to distil and present in an informative and entertaining way his knowledge of the biology and ecology of Australia's snakes gained during 20-odd years study in the field, laboratory experimentation and painstaking dissection of thousands of museum specimens. His stated aims in writing the book are to provide easily understood information on Australian snakes, encourage the appreciation of snakes as an integral part of the fauna, and to produce the kind of book he would have liked to have as a teenager. Accordingly, the book is not so much pitched at professionals as the laity, particularly the young herpetologist looking for guidance.

There are eight chapters dealing with anatomy, evolution, where snakes live, their behaviour, sex life, life histories, diet, and finally the relationship between snakes and humans. There is also an appendix, a glossary and a selected bibliography. The first two chapters explain the anatomy and evolution of snakes while the remaining chapters draw mostly on the author's own and collaborative research. As a museum employee always answering public enquiries I find the appendix most useful. It is a five page table summarising a vast amount of data previously published in 100-odd papers. It included data on the size of hatchlings, adult males and females, type of reproduction, number of offspring and dietary details for 115 species of snake.

The many photographs are of high quality and are, in most cases selected for their animation - a quick flick through the book gives the impression of snakes in action.

My complaints are few and mostly cosmetic. In pursuit of a dramatic, dynamic layout some photographs have been savagely trimmed to the point where they detract from the aesthetics of the book. For example, the photograph of *Suta gouldii* on p83. In some cases, such as the death adder on p84, the "caption" is printed on the plate making it very difficult to read. I found one typographic error. But these are mere quibbles and in no way detract from the value of the book. In my view Rick Shine has achieved the aims stated in his preface.

I recommend it to all naturalists and would like to see it in as many school libraries as possible.

L. Smith, Western Australian Museum

BOOK REVIEW
SKINKS OF THE NORTHERN TERRITORY

Horner, Paul, 1991. Skinks of the Northern Territory. Northern Territory Museum Handbook Series, No. 2; Northern Territory Museum of Arts and Sciences, Darwin; 174 pp. Rec. Retail Price $19.95 (plus postage).

One of the relatively recent trends in the development of reptile biology in Australia is the production of identification guides dedicated to various geographic areas of the country. The tradition of regional guides began with Edgar Waite's (1929) classic Reptiles and Amphibians of South Australia, a "guide" that remains unsurpassed for its readability and generally engaging style. It was followed after a space of just over thirty years by Glauert's two handbooks on the snakes (three editions: 1950, 1957, 1967, last only cited below) and lizards (1961) of Western Australia. After another lengthy period, Houston's (1976) work on the dragons and goannas of South Australia appeared and from then on the pace of publication picked up with Storr and co-workers' four volume treatment of the lizards (1981, 1983, 1990) and snakes (1986) of Western Australia, Swan's (1990) lizards and snakes of New South Wales, Weigel's (1990) snakes of southeastern Australia, and Coventry and Robertson's (1991) snakes of Victoria. Along the way there have been the very local guides dedicated to small but high interest areas such as Brisbane (snakes only, Covacevich, 1970), the Darwin area (snakes only, Gow, 1977), the high country of the Southern Tablelands of southeastern Australia (Jenkins and Bartell, 1980), the Esperance area of Western Australia (Bush, 1981), and the Sydney region (Griffiths, 1987). The latest book in this series of regional guides is Paul Horner's work on the skinks of the Northern Territory.

Horner's book "works" by providing a key to the genera of skinks in the NT followed by various generic keys to arrive at the species. The identification can then be confirmed by reference to the species account which includes: the "distinctive features", a more extended description under the section "definition", a spot distribution map for the NT, a colour picture of the living animal, and, in many cases, a brief list of similar species. Once the animal is confidently identified, additional natural history information can be obtained from the sections on "habitat" and "remarks". The details of the species accounts are concise and laid out in exemplary parallel fashion making rapid comparison amongst species very easy. In addition to the keys and species accounts which are the core of the book, there is also a brief orientation into skink external morphology, a glossary, a tabular distribution of species by biogeographic region in the NT, checklists both of the skink species from the NT and of the species that come close to the NT (and which therefore might be found there in the future), a list of references, and an index. The book is very nicely produced with good quality paper, printing, and colour reproduction. The overall result is a product that one is pleased to own and use.

Skinks are the largest and most widespread group of lizards in Australia. This makes them very important in faunal surveys and general ecological work. Skinks are also probably the most difficult group of lizards to identify due to their generally small size, and subtle colour and scale variations. This makes skink identification a difficult and uncertain task for all but a handful of experts. Horner is one of these experts, and he has now imparted his knowledge in a very user-friendly format. This should open up skink identification to a variety of potential users in the NT, including conservationists, ecologists, students, keepers, wildlife photographers, law enforcement officers, and faunal bureaucrats.

By considering only a small geographic subsection of the Australian fauna, regional guides can simplify identification for users whose interests are restricted to that area or for whom more general guides would be daunting. In this regard these guides have important practical and teaching functions. Regional guides also provide an opportunity to discuss local population

variation, distribution, ecology and behaviour. In this they can be important for people with more advanced interests. There is still vast scope for regional guides as many areas and many taxonomic groups remain to be covered by this kind of work. Hopefully Paul Horner and other workers with detailed local knowledge will continue to produce these very useful books.

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Allen E. Greer
16 July 1992

NOTES TO CONTRIBUTORS

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